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ABSTRACT

This paper presents the detailed propositional analyses of the text employed in a study that compared the contents of recall protocols of high knowledge (HK) and low knowledge (LK) groups. The paper also includes the propositional analyses of the recall protocols of the HK and LK individuals, as well as detailed analyses of the results. (Author/FL)

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TEXT PROCESSING OF DOMAIN-RELATED INFORMATION FOR INDIVIDUALS WITH HIGH AND LOW DOMAIN KNOWLEDGE: METHODOLOGICAL CONSIDERATIONS

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University of Pittsburgh

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The paper entitled "Text Processing of Domain-Related Information for Individuals with High and Low Domain Knowledge" (Spilich, Vesonder, Chiesi, & Voss, in press) presented the results of an experiment which involved use of textual materia.. A one-half inning account of a baseball game was presented to individuals with either high (HK) or low (LK) baseball knowledge, and subsequently the individuals were asked to recall the contents of the account. The purpose of the study was, of course, to compare the contents of the recall protocols of the HK and LK groups by assessing both quantitative and qualitative differences in recall. The results indicated that HK recall was quantitatively and qualitatively superior to that of LK recall, and the findings were considered in terms of the superiority of HK individuals to relate game actions and sequences of such actions to the goal structure of the game. In order to provide a reasonable analysis of protocol differences, it was necessary to perform a number of detailed analyses. However, because of length, the details of these analyses were not contained in the aforementioned paper. It is therefore the purpose of this paper to present such analyses in detail. More specifically, this paper presents the procedures used to analyze the text employed in the aforementioned study and also presents in detail the procedures used in the scoring of the recall protocols.

The Propositional Analysis of the Text

Table 1 presents the text that was used in the Spilich, Vesonder, Chiesi, and Voss (in press) paper. The text is a one-inning account of a fictitious baseball game.

Table 1

Baseball Text

The Ridgeville Robins are playing the Center City Cougars. The Robins are leading 5-3 with the Cougars at bat in the last half of the fifth inning. The sky is getting darker, and the rain that has started is becoming heavier. The Cougars' first batter, Harvey Jones, is taking his time coming to plate. The umpire steps back from behind the plate and tells him to step into the batter's box.

Jones, the hitter, is left-handed, and has a batting average of .310. Claresen, the pitcher, has allowed only four hits, has walked one, and has struck out six. This performance is about average for Claresen since this left-hander has an earned-run average of 6.00 and typically strikes out quite a few batters.

Claresen now adjusts his cap, touches his knee, begins his wind-up, and delivers a high fast ball that the umpire calls "Ball One." The Robins's catcher, Don Postman, returns the ball, and Claresen takes the sign. The next pitch is swung on and hit to centerfield. Maloney comes in and catches it for the first out.

The next batter is the powerful hitter, Fred Johnson, who leads the league in home runs with 23. Claresen no doubt is glad to face him with no one on base. Claresen is now getting his sign from the catcher, begins his windup, and throws a curve ball breaking into the right-hand batter at the knees. The umpire calls it for a strike. Claresen is now getting ready again, winds up and throws, and Johnson hits it off to right and into the stands, a foul ball. The count is now 0 and 2. Claresen rubs up the new ball, takes his sign, and throws a fast ball which just misses the bill of Johnson's cap. Johnson took one step toward the mound, but then came back. Johnson stepped out of the batter's box and put some resin on his hands; the bat is no doubt slippery from the rain. Claresen is ready again, winds up and throws a slider which breaks inside, making the count 2-2. Once more Johnson steps out of the batter's box and gets some resin on his hands. He steps back in and Claresen starts his motion and throws. Johnson swings and has a line drive down the left field line. Ferraro runs over to get the ball as Johnson rounds first and goes toward second. Ferraro's throw is late and Johnson is safe on second with a double.

Beck, the left-handed relief pitcher, is warming up in the bullpen. The next hitter for the Cougars is the right-hand hitting Carl Churniak, a .260 hitter who is known to hit well in the clutch. Claresen takes his sign, delivers, and Churniak takes the pitch for a ball. Claresen again is ready and pitches, and Churniak swings and hits a slow bouncing ball toward the shortstop. Haley comes in, fields it, and throws to first, but too late. Churniak is on first with a single; Johnson stayed on second.

The next batter is Whitcomb, the Cougars' left-fielder. He is a left-hander hitting .255. Claresen wipes his forehead with his sleeve and takes his sign. Claresen looks toward first, where Manfred is holding the runner. He stretches, looks at second, and throws a nigh fast ball for a strike. The catcher returns the ball and Claresen once more gets ready. Claresen throws a low curve ball. It bounces into the dirt and past the catcher. Johnson moves to third and Churniak to second before the catcher can retrieve the ball. The ball is returned to Claresen. He gets the sign and winds up, and throws a slider that Whitcomb hits between Manfred and Roberts for a hit. Dulaney comes in and picks up the ball. Johnson has scored, and Churniak is heading for the plate. Here comes the throw, and Churniak is out. Churniak argues, but to no avail. The batter reached second on the throw to the plate.

The next batter is Rob Williams, the Cougar's catcher. He is hitting .230. Claresen is rubbing up the ball and now is ready to pitch. The rain is coming down in sheets. Claresen delivers and Williams takes a curve over the inside corner for a strike. Working rapidly, Claresen again delivers and Williams takes a ball, low and outside. Claresen again gets the sign, stretches, and throws a fast ball, which Williams swings at and misses. The catcher returns the ball and Claresen is ready. The pitch is a curve ball which Williams swings at and misses for his third strike.

The umpires now are meeting and they signal that the game is being called.

Table 2a presents the propositional analysis that was performed on the text. The method of analysis was essentially that developed by Kintsch (1974) and Turner and Greene (in press). The traditional propositional notation was not employed, however, although each proposition could readily be expressed in terms of its predicate and argument(s). Table 2b presents the propositions in the more traditional notation.

Table 2a

Propositional Structure of Baseball Passage and Classification of Propositions According to Baseball Knowledge Structure

	0.	There exists a baseball game
SG	1.	Team - Ridgeville Robins
SG	2.	Team - Center City Cougars
G2	3.	Score - 5-3
G2	4.	Team ahead - Robins
SG	5.	Team batting - Cougars
SG	6.	Inning - fifth
SG	7.	Half Inning - last (of the fifth)
SG	8.	Weather - sky dark, rain, heavy rain (not "sheets," that is later)
E	9.	(First) batter comes up to bat
SSI	10.	First batter - name is Jones
NAI	11.	Batter is slow to come to plate
NAI	12.	Cause - 11, stalling (to try to get game called, Score, Rain, etc.)
NAI	13.	Umpire - tells batter to get in batter's box
SSR	14.	Batter - left-hand hitter
SSR	15.	Batter - average is .310
SSR	16.	Batter - a good hitter
E	17.	Pitcher acknowledged (assume for team in field)
SSI	18.	Pitcher's name is Claresen
SSR	19.	Pitcher is left-handed
SSR	20.	Pitcher's record in game - given up 4 hits
SSR	21.	Pitcher's record in game - given up 1 walk
SSR	22.	Pitcher's record in game - 6 strikeouts
SSR	23.	Pitcher's record - quite a few strikeouts
SSR	24.	Pitcher's record in game - typical
SSR	25.	Pitcher's E.R.A. - 6.00
SSR	26.	Pitcher's E.R.A. is high
SSR	27.	Because 26, pitcher is not good

NAI 28. Pitcher adjusts cap

NAI 29. Pitcher touches knee

A4A 30. Pitcher winds up and pitches

A4A 31. Pitch is fast ball

A4 32. Umpire calls "Ball" (pitch is ball)

G4 33. Ball 1

SSI 34. Robins' catcher is Postman

NAI 35. Postman returns ball to pitcher (after pitch)

NAR 36. Claresen gets sign

A4A 37. Claresen pitches

A3A 38. Batter (Jones) hits ball

A3A 39. Ball goes to center field

A3A 40. Ball is caught

SSI 41. Caught by Maloney

SSI 42. Maloney is Robins' centerfielder

A3 43. First batter (Jones) is out

G3 44. 1 out

E 45. Next batter is up

SSI 46. Batter's name is Johnson

SSI 47. Batter is second batter

SSR 48. Batter has hit 23 home runs

SSR 49. Batter leads league in home runs

SSR 50. Batter is power hitter

SSR 51. Batter's ave. (not in text)

SSI 52. Pitcher is glad no one is on base when Johnson (this batter) is batting

NAR 53. Pitcher (Claresen) gets sign

A4A 54. Pitcher throws pitch

A4A 55. Pitch is curve ball

A4A 56. Pitch breaks into batter at knees

SSR 57. Batter is right-handed (inference)

A4 58. Pitch is strike

G4 59. Strike 1

A4A 60. Clarensen pitches

A4A 61. Batter hits ball

A4A 62. Batter (Johnson) hits foul

NAI 63. Foul is to right
G4 64. Strike 2
NAI 65. Claresen rubs ball
NAR 66. Claresen gets sign
A4A 67. Claresen (pitcher) throws
A4A 68. Pitch is fast ball
A4A 69. Pitch is high
A4A 70. Pitch just misses batter
SSI 71. Pitch just misses bill of batter's cap
A4A 72. Pitch is brushback pitch
A4 73. Pitch is Ball
G4 74. Ball 1
G4 75. Count is Ball 1 - Strike 2
NAI 76. Batter (Johnson) steps toward mound
NAI 77. Cause 76, 72
NAI 78. Batter (Johnson) comes back
NAI 79. Batter steps out of batter's box
NAI 80. Batter gets resin bag
NAI 81. Batter puts resin on hands
NAI 82. Cause 81, bat slippery due to rain
SSI 83. Pitcher (Claresen) is ready
NAI 84. Pitcher winds up
A4A 85. Pitcher delivers pitch
A4A 86. Pitch is slider
A4A 87. Slider breaks inside
A4 88. Pitch is "Ball"
G4 89. Ball 2
G4 90. Count is 2-2
NAI 91. Batter (Johnson) again steps out of batter's box
NAI 92. Batter again gets resin bag
NAI 93. Batter again puts resin on hands
NAI 94. Pitcher (Claresen) starts motion
A4A 95. Pitcher throws
A3A 96. Batter (Johnson) hits ball
A3A 97. Hit ball is line drive

A3A 98. Ball goes to left field
A3A 99. Ball goes down line of left field
A3A 100. Left fielder runs to get ball
SSI 101. Ferraro is Robins' left fielder
A3 102. Batter (Johnson) is safe at second
A3A 103. Batter gets double (Credit given for 102)
G3 104. Runner at second base (Cougars)
A3A 105. Left fielder's (Ferraro) throw late
NAR 106. Pitcher in bullpen (Assume Robins)
NAI 107. Warming up in bullpen
SSI 108. Pitcher's name is Beck
SSR 109. Pitcher is left-handed
SSR 110. Pitcher is relief pitcher
SSR 111. Current pitcher (Claresen) is in trouble
SSR 112. Cause 111, 104
E 113. Next batter comes up
SSI 114. Next batter is third batter
SSI 115. Next batter's name is Churniak
SSR 116. Batter is right-handed
SSR 117. Batter's batting average is .260
SSR 118. Batter is fair hitter
SSR 119. Batter known as clutch hitter
NAR 120. Pitcher (Claresen) takes sign
A4A 121. Pitcher pitches
A4A 122. Batter (Churniak) takes pitch
A4 123. Pitch is a ball
G4 124. Ball 1
SSI 125. Pitcher (Claresen) is ready
A4A 126. Pitcher pitches
A3A 127. Batter (Churniak) hits ball (Omitted batter swings)
A3A 128. Ball hit is slow ground ball
A3A 129. Ground ball goes toward shortstop
A3A 130. Shortstop comes in (for ball)
A3A 131. Shortstop fields ball
A3A 132. Shortstop throws to first base

A3A 133. Throw is late

A3 134. Batter (Churniak) is safe at first base (Credit given for getting hit)

A3A 135. Batter (Churniak) has single

G3 136. Runners on first and second base (Cougars)

G3 137. Runner on second stayed at second base

SSI 138. Runner on second was Johnson

A3A 139. Cause 136, ball hit to left side of infield

SSI 140. Shortstop's name is Haley

E 141. Next batter comes up

SSI 142. Batter is fourth batter

SSI 143. Batter's name is Whitcomb

SSI 144. Batter is Cougars' left fielder

SSR 145. Batter bats left-handed

SSR 146. Batter's average is .255

SSR 147. Batter is fair hitter (or poor)

NAI 148. Pitcher (Claresen) wipes forehead with sleeve

NAR 149. Pitcher (Claresen) takes sign

NAR 150. Pitcher (Claresen) looks toward first base

NAR 151. First baseman is holding runner (keeping him close to first)

SSI 152. First baseman's name is Manfred

NAI 153. Pitcher (Claresen) stretches

A4A 154. Pitcher (Claresen) looks at second base

A4A 155. Pitcher (Claresen) pitches

A4A 156. Batter takes pitch

A4A 157. Pitch is high

A4A 158. Pitch is fast ball

A4 159. Pitch is strike

G4 160. Strike 1

NAI 161. Catcher returns ball to Claresen (pitcher)

NAI 162. Pitcher (Claresen) gets ready

A4A 163. Pitcher Claresen) pitches

A4A 164. Pitch is curve ball

A4A 165. Pitch is low (pitch is ball)

A4A 166. Pitch bounces in dirt

A4A 167. Ball bounces past catcher
A3 168. Runner from second goes to third
SSI 169. Runner is Johnson
A3 170. Runner from first goes to second
SSI 171. Runner is Churniak
A4A 172. Pitch was wild pitch (defined by 164, 166, 168)
NAR 173. 166, 168 before catcher could get ball
G3 174. Runners on second and third
G4 175. Pitch was ball
G4 176. Ball 1
G4 177. Ball 1 - Strike 1
NAI 178. Catcher returns ball to pitcher
NAR 179. Pitcher (Claresen) gets sign
NAI 180. Pitcher (Claresen) winds up
A4A 181. Pitcher pitches
A4A 182. Pitch is slider
A2A 183. Batter hits pitch
A2A 184. Ball goes between two players
A2A 185. Ball goes between first and second
A3 186. Batter (Whitcomb) gets a hit (single) - safe at first base
A2A 187. Ball is hit to outfield (right field)
SSI 188. Two players (183) are Manfred and Roberts
SSI 189. Name of second baseman is Roberts (Inference since 150)
A2A 190. Right fielder comes in to field ball
SSI 191. Name of right fielder is Delaney
A2A 192. Right fielder picks up ball
A2 193. Runner on third scores
SSI 194. Runner is Johnson
G2 195. Score - 5-4
A3A 196. Runner from second goes toward home plate
SSI 197. Runner is Churniak
A3A 198. Throw comes (from Delaney)
A3 199. Runner is out at home plate
G3 200. Second out of half-inning
NAI 201. Runner out at home argues

NAI 202. Runner loses argument (to no avail)
SSI 203. Runner arguing is Churniak
A3 204. Batter advances to second base
SSI 205. Batter is Whitcomb
A3A 206. Cause of 202 - throw to home plate (196)
G3 207. Runner on second base
E 208. Next batter comes up
SSI 209. Name of next batter is Williams
SSI 210. Batter is fifth batter
SSI 211. Batter is Cougars' catcher
SSR 212. Batter is hitting .230
SSR 213. Batter is poor hitter
NAI 214. Pitcher (Claresen) rubs ball
NAI 215. Pitcher is ready
SG 216. It is raining hard (sheets)
A4A 217. Pitcher pitches
A4A 218. Batter takes pitch
A4A 219. Pitch is curve
A4A 220. Pitch is over inside corner (of plate)
A4 221. Pitch is strike
G4 222. Strike 1
NAI 223. Pitcher works rapidly
NAI 224. Inference - 223 (because it is raining hard, etc.)
A4A 225. Pitcher pitches
A4A 226. Batter takes pitch
A4 227. Pitch is a ball
G4 228. Ball 1
G4 229. Count - Ball 1 - Strike 1
A4A 230. Pitcher pitches (Inference)
A4A 231. Pitch is low
A4A 232. Pitch is outside
A4 233. Pitch is ball
G4 234. Ball 2
G4 235. Count - Ball 2 - Strike 1
NAR 236. Pitcher gets sign

NAI	237.	Pitcher stretches
A4A	238.	Pitcher throws
A4A	239.	Pitch is fast ball
A4A	240.	Batter swings
A4A	241.	Batter misses
A4	242.	Pitch is strike
G4	243	Strike 1
G4	244.	Ball 2 - Strike 2
NAI	245.	Catcher returns ball to pitcher
NAR	246.	Pitcher is ready
A3A	247.	Pitcher pitches
A3A	248.	Pitch is curve
A3A	249.	Batter swings
A3A	250.	Batter misses
A3	251.	Batter strikes out
G4	252.	Ball 2 - Strike 3
G3	253.	Out 3
SG	254.	Half-inning over (side retired)
SG	255.	Inning 6
NAR	256.	Umpires meet
SG	257.	Umpires signal game is called (terminated)
SG	258.	Cause, 257 - rain (inferred)
G2	259.	Team ahead when game is called
G2	260.	Score when game is called
G1	261.	Robins win
G1	262.	Cougars lose
G1	263.	Game official (5 innings)
SSR	264.	Cl[illegible]en was winning pitcher

Table 2b

Propositional Structure (Traditional Notation)

0. (EXIST, BASEBALL GAME)
1. (ISA, TEAM PLAYING, RIDGEVILLE ROBINS)
2. (ISA, TEAM PLAYING, CENTER CITY COUGARS)
3. (QUALITY, SCORE, 5-3)
4. (QUALIFY, 3, TEAM AHEAD, ROBINS)
5. (QUALITY, TEAM AT BAT, COUGARS)
6. (QUALITY, INNING, 5TH)
7. (QUALIFY, 6, LAST HALF)
8. (QUALITY, WEATHER, DARK, RAINY)
9. (COME, FIRST BATTER, TO BAT)
10. (QUALIFY, 9, JONES)
11. (QUALIFY, 9, SLOWLY)
12. (CAUSE, 11, STALL)
13. (TELL, UMPIRE, BATTER, 9)
14. (QUALITY, 10, LEFT-HAND BATTER)
15. (QUALITY, 10, AVERAGE OF .310)
16. (IMPLY, 15, BATTER GOOD)
17. (EXIST, PITCHER)
18. (QUALIFY, 17, CLARESEN)
19. (QUALIFY, 17, LEFT-HANDED)
20. (QUALIFY, 17, 4 HITS IN GAME)
21. (QUALIFY, 17, 1 WALK IN GAME)
22. (QUALIFY, 17, 6 STRIKEOUTS IN GAME)
23. (IMPLY, 22, MANY STRIKEOUTS)
24. (QUALIFY, 20, 21, 22, TYPICAL)
25. (QUALIFY, 17, E.R.A. IS 6.00)
26. (IMPLY, 25, HIGH)
27. (IMPLY, 26, PITCHER NOT GOOD)
28. (ADJUST, 17, CAP)
29. (TOUCH, 17, KNEE)
30. (WINDS AND PITCHES, 17)

31. (QUALITY, PITCH, FAST BALL)
32. (CALL, UMPIRE, "BALL")
33. (QUALITY, "BALL," 1)
34. (NAME, CATCHER, POSTMAN)
35. (RETURN, BALL, CATCHER, PITCHER)
36. (OBTAIN, PITCHER, SIGN)
37. (PITCHES, PITCHER)
38. (HITS, BATTER, BALL)
39. (MOVE, BALL, CENTER FIELD)
40. (CATCH, BALL)
41. (QUALIFY, 40, MALONEY)
42. (QUALIFY, MALONEY, CENTER FIELDER)
43. (QUALITY, BATTER, OUT)
44. (QUALITY, "OUT," 1)
45. (COME, NEXT BATTER, TO BAT)
46. (QUALIFY, 45, JOHNSON)
47. (QUALIFY, 45, SECOND BATTER)
48. (QUALIFY, 45, 23 HOME RUNS)
49. (CAUSE, 48, LEADS LEAGUE)
50. (IMPLY, 48, POWER HITTER)
51. (QUALIFY, 46, AVERAGE)
52. (QUALITY, PITCHER, GLAD, NO ONE ON BASE)
53. (GETS, PITCHER, SIGN)
54. (THROW, PITCHER, PITCH)
55. (QUALITY, PITCH, CURVE)
56. (BREAK, PITCH, BATTER'S KNEES)
57. (QUALITY, BATTER, RIGHT-HANDED)
58. (QUALITY, PITCH, STRIKE)
59. (QUALITY, "STRIKE," 1)
60. (PITCHES, PITCHER)
61. (HIT, BATTER, BALL)
62. (HIT, BALL FOUL)
63. (LOC., FOUL, RIGHT)
64. (QUALITY, "STRIKE," 2)
65. (RUB, PITCHER, BALL)

66. (GET, PITCHER, SIGN)
67. (THROW, PITCHER, BALL)
68. (QUALITY, PITCH, FAST BALL)
69. (QUALITY, PITCH, HIGH)
70. (MISS, PITCH, BATTER, BARELY)
71. (QUALIFY, 70, BILL OF CAP)
72. (IMPLY, 70, BRUSHBACK PITCH)
73. (QUALITY, PITCH, "BALL")
74. (QUALITY, BALL, 1)
75. (QUALITY, COUNT, BALL 1, STRIKE 2)
76. (STEP, BATTER, PITCHER)
77. (CAUSE, 76, 72)
78. (COME, BATTER, BACK)
79. (STEP, BATTER, OUT OF BOX)
80. (GET, BATTER, RESIN BAG)
81. (PLACE, 80, HANDS)
82. (CAUSE, 80, RAIN)
83. (QUALITY, PITCHER, READY)
84. (WIND, PITCHER)
85. (DELIVER, PITCHER, PITCH)
86. (QUALITY, PITCH, SLIDER)
87. (BREAK, SLIDER, INSIDE)
88. (QUALITY, PITCH, "BALL")
89. QUALITY, "BALL," 2)
90. (QUALITY, COUNT, BALL 2, STRIKE 2)
91. (STEP, BATTER, OUT OF BOX, AGAIN)
92. (GET, BATTER, RESIN BAG, AGAIN)
93. (PLACE, 92, AGAIN)
94. (START, PITCHER, MOTION)
95. (THROW, PITCHER, BALL)
96. (HIT, BATTER, BALL)
97. (QUALITY, HIT, LINE DRIVE)
98. (MOVE, BALL, LEFT FIELD)
99. (MOVE, BALL, LEFT FIELD LINE)
100. (RUN, LEFT FIELDER, BALL)

101. (QUALIFY, LEFT FIELDER, FERRARO)
102. (QUALITY, BATTER, SAFE, SECOND BASE)
103. (GET, BATTER, DOUBLE)
104. (QUALITY, RUNNER, SECOND BASE)
105. (THROW, LEFT FIELDER, LATE)
106. (EXIST, PITCHER, BULLPEN)
107. (QUALIFY, 106, WARMING UP)
108. (QUALIFY, 106, BECK)
109. (QUALIFY, 106, LEFT-HANDED)
110. (QUALIFY, 106, RELIEF PITCHER)
111. (QUALITY, PITCHER, TROUBLE)
112. (CAUSE, 111, 104)
113. (COME, NEXT BATTER, TO BAT)
114. (QUALIFY 113, THIRD BATTER)
115. (QUALIFY, 113, CHURNIAK)
116. (QUALIFY, 113, RIGHT-HANDED)
117. (QUALIFY, 113, AVERAGE .260)
118. (IMPLY, 117, FAIR HITTER)
119. (QUALITY, BATTER, CLUTCH HITTER)
120. (GET, PITCHER, SIGN)
121. (PITCH, PITCHER)
122. (TAKE, BATTER, PITCH)
123. (QUALITY, PITCH, "BALL")
124. (QUALITY, BALL, 1)
125. (QUALITY, PITCHER, READY)
126. (PITCH, PITCHER)
127. (HIT, BATTER, BALL)
128. (QUALITY, 127, SLOW GROUND BALL)
129. (MOVE, BALL, SHORTSTOP)
130. (MOVE, SHORTSTOP, BALL)
131. (FIELD, SHORTSTOP, BALL)
132. (THROW, SHORTSTOP, BALL, FIRST BASE)
133. (QUALITY, THROW, LATE)
134. (QUALITY, BATTER, SAFE, FIRST BASE)
135. (GET, BATTER, SINGLE)
136. (QUALITY, RUNNERS, FIRST AND SECOND BASES)

137. (QUALITY, RUNNER, SECOND BASE)
138. (QUALIFY, 137, JOHNSON)
139. (CAUSE, 136, 129)
140. (QUALIFY, 129, HALEY)
141. (COME, NEXT BATTER, TO BAT)
142. (QUALIFY, BATTER, FOURTH BATTER)
143. (QUALIFY, BATTER, WHITCOMB)
144. (QUALIFY, BATTER, LEFT FIELDER)
145. (QUALIFY, BATTER, LEFT-HANDED)
146. (QUALIFY, BATTER, AVERAGE .255)
147. (IMPLY, 146, FAIR BATTER)
148. (WIPE, PITCHER, FOREHEAD, SLEEVE)
149. (TAKE, PITCHER, SIGN)
150. (LOOK, PITCHER, FIRST BASE)
151. (HOLD, PITCHER, RUNNER)
152. (QUALIFY, FIRST BASEMAN, MANFRED)
153. (STRETCH, PITCHER)
154. (LOOK, PITCHER, SECOND BASE)
155. (PITCH, PITCHER)
156. (TAKE, BATTER, PITCH)
157. (QUALITY, PITCH, HIGH)
158. (QUALITY, PITCH, FAST BALL)
159. (QUALITY, PITCH, STRIKE)
160. (QUALITY, STRIKE, 1)
161. (RETURN, CATCHER, BALL, PITCHER)
162. (GET, PITCHER, READY)
163. (PITCH, PITCHER)
164. (QUALITY, PITCH, CURVE)
165. (QUALITY, PITCH, LOW)
166. (BOUNCE, PITCH, DIRT)
167. (BOUNCE, BALL, CATCHER)
168. (GO, RUNNER, SECOND, THIRD)
169. (QUALIFY, RUNNER, JOHNSON)
170. (GO, RUNNER, FIRST, SECOND)
171. (QUALIFY, RUNNER, CHURNIAK)

172. (IMPLY, 164, 166, 168, WILD PITCH)
173. (MOVE, 166, 168, CATCHER, BALL)
174. (QUALITY, RUNNERS, SECOND, THIRD)
175. (QUALITY, PITCH, BALL)
176. (QUALITY, BALL, 1)
177. (QUALITY, COUNT, BALL 1, STRIKE 1)
178. (RETURN, CATCHER, BALL, PITCHER)
179. (GET, PITCHER, SIGN)
180. (WIND, PITCHER)
181. (PITCH, PITCHER)
182. (QUALITY, PITCH, SLIDER)
183. (HIT, BATTER, PITCH)
184. (MOVE, BALL, TWO PLAYERS)
185. (QUALIFY, 184, FIRST AND SECOND BASE)
186. (HIT, BATTER, SINGLE)
187. (HIT, BATTER, BALL, RIGHT FIELD)
188. (QUALIFY, 1, MANFRED, ROBERTS)
189. (IMPLY, 188, 150)
190. (MOVE, RIGHT FIELDER, BALL)
191. (QUALIFY, RIGHT FIELDER, DELANEY)
192. (PICKUP, RIGHT FIELDER, BALL)
193. (SCORE, RUNNER, THIRD BASE)
194. (QUALIFY, 193)
195. (QUALITY, SCORE, 5-4)
196. (GO, RUNNER, SECOND BASE, HOME PLATE)
197. (QUALIFY, 196, CHURNIAK)
198. (COME, THROW, RIGHT FIELDER)
199. (QUALITY, RUNNER, OUT, HOME PLATE)
200. (QUALITY, OUT, 2)
201. (ARGUE, RUNNER, HOME PLATE)
202. (LOSE, RUNNER, ARGUMENT)
203. (QUALIFY, 201, CHURNIAK)
204. (GO, BATTER, SECOND BASE)
205. (QUALIFY, RUNNER, WHITCOMB)
206. (CAUSE, 202, 196)
207. (QUALITY, RUNNER, SECOND BASE)

208. (COME, NEXT BATTER, TO BAT)
209. (QUALIFY, BATTER, WILLIAMS)
210. (QUALIFY, BATTER, FIFTH)
211. (QUALIFY, BATTER, CATCHER)
212. (QUALIFY, BATTER, AVERAGE .230)
213. (IMPLY, 212, POOR HITTER)
214. (RUB, PITCHER, BALL)
215. (QUALITY, PITCHER, READY)
216. (RAINING, SHEETS)
217. (PITCH, PITCHER)
218. (TAKE, BATTER, PITCH)
219. (QUALITY, PITCH, CURVE)
220. (QUALITY, PITCH, INSIDE CORNER)
221. (QUALITY, PITCH, STRIKE)
222. (QUALITY, STRIKE, 1)
223. (WORK, PITCHER, RAPIDLY)
224. (CAUSE, 223, 216)
225. (PITCH, PITCHER)
226. (TAKE, BATTER, PITCH)
227. (QUALITY, PITCH, BALL)
228. (QUALITY, BALL, 1)
229. (QUALITY, COUNT, BALL 1, STRIKE 1)
230. (PITCH, PITCHER)
231. (QUALIFY, PITCH, LOW)
232. (QUALIFY, PITCH, OUTSIDE)
233. (QUALITY, PITCH, BALL)
234. (QUALITY, BALL, 2)
235. (QUALITY, COUNT, BALL 2, STRIKE 1)
236. (GET, PITCHER, SIGN)
237. (STRETCH, PITCHER)
238. (THROW, PITCHER, BALL)
239. (QUALITY, PITCH, FAST BALL)
240. (SWING, BATTER)
241. (MISS, BATTER, BALL)
242. (QUALITY, PITCH, STRIKE)

243. (QUALITY, STRIKE, 1)
244. (QUALITY, COUNT, BALL 2, STRIKE 2)
245. (RETURN, CATCHER, BALL, PITCHER)
246. (QUALITY, PITCHER, READY)
247. (PITCH, PITCHER)
248. (QUALITY, PITCH, CURVE)
249. (SWING, BATTER)
250. (MISS, BATTER)
251. (STRIKE OUT, BATTER)
252. (QUALITY, COUNT, BALL 2, STRIKE 3)
253. (QUALITY, OUT, 3)
254. (QUALITY, INNING, OVER)
255. (IMPLY, INNING, SIXTH)
256. (MEET, UMPIRES)
257. (CALL OFF, UMPIRES, GAME)
258. (CAUSE, 257, 216)
259. (QUALITY, TEAM, ROBINS)
260. (QUALITY, 257, 195)
261. (QUALITY, WINNER, ROBINS)
262. (QUALITY, LOSER, COUGARS)
263. (QUALITY, GAME, OFFICIAL)
264. (QUALITY, WINNING PITCHER, CLARESEN)

One point about the propositional analysis is that some propositions could be derived from the text which are not included in the analysis of Table 2a. These primarily are not important to the account and in some cases are somewhat arbitrary. For example, Proposition 52, which is concerned with the assertion that the pitcher was glad that he was facing a particular batter when no runners were on base, could be divided into at least two propositions, but this was not done because the basic content of the assertion could be contained in a single proposition. A second point is that a few propositions were placed in the structure because the recall protocols necessitated their inclusion.

While the propositional structure was by no means data driven, it was necessary to include those few propositions because of the contents of one or two protocols. For example, Proposition 27 states that the pitcher, based upon his record, was not a good pitcher. This is a conclusion that is implied by the text information. It should be reiterated, however, that there were only a few such propositions included in the text.

The most important aspect of the propositional structure involves the classification of the propositions that is presented in the left column of Table 2a. The text propositions are classified according to a baseball knowledge structure, and this structure is presented in Table 3. The structure pertains to the knowledge that is involved in the play of the game and not to all baseball knowledge. (Specific leagues, teams, and players, for example, are not considered.)

The uppermost part of the structure depicted in Table 3 is setting information. There is general setting information which refers to the teams playing, the inning (or half-inning) of the game, and any general information that could influence the play of the game. The specific setting information pertains to information that involves a particular team, player, or some other component of the game. There are two types of specific setting information, relevant and irrelevant. The first includes information that is of some relevance to the game but not involved in the game per se. For example, a player's batting average indicates the general success of that player in getting hits, and, while this statistic has no direct bearing on what a person does when at bat, it is relevant in the sense of providing an idea of how good a hitter the individual is. It also states the probability of that person getting a hit (other things being equal). Thus, the specific setting information that is relevant includes most of the statistics kept for particular

Table 3

Baseball Knowledge Structure

Setting

General:	Teams Playing, Team at Bat, Team in Field, Inning, Miscellaneous Conditions
Specific:	Relevant--Teams' Records as Related to Goal Structure, Players' Records as Related to Goal Structure
	Irrelevant--Team Attributes, Player Attributes
Enabling:	Batter at Bat and Pitcher Ready to Pitch

Goal Structure

Team at Bat	Level	Variables	Values	Team in Field
Winning game	1	Game outcome	Win-lose	Winning game
Scoring runs	2	Score	Domain of game scores	Preventing runs from scoring
Getting runners on base and advancing runners	3	Pattern of base runners Outs	Eight possible patterns 0, 1, 2, 3	Preventing runners from getting on base or advancing by making outs
Having "balls," avoiding "strikes"	4	"Balls" "Strikes"	0, 1, 2, 3, 4 0, 1, 2, 3	Getting "strikes," avoiding "balls"

Non-game Actions

---	Relevant non-game actions
---	Irrelevant non-game actions

teams and individual players. The irrelevant specific setting category includes information that does not relate to the play of the game. Examples of this type of information include the color of the uniforms and the numbers worn by the players. The enabling setting information category consists of the information pertaining to game activity initiation. Examples of this information include the members of one team being in the field with the pitcher being ready to pitch and the batter at bat.

In the list of propositions of Table 2a, general setting propositions are denoted SG, and specific setting propositions are denoted SSR and SSI, depending upon whether they are relevant or irrelevant, respectively. The enabling propositions are denoted E.

The next category of the knowledge structure of Table 3 is that of the goal structure. It is assumed that baseball has a hierarchical goal structure involving four levels. The highest level consists of winning the game. The remaining levels consist of subgoals which are related to winning the game. The second-level goal is scoring runs (team at bat) and preventing runs from being scored (team in field). The third level is getting a batter on base and advancing runners (team at bat) and making batters out and preventing runners from advancing by making them out (team in field). The fourth level involves events connected with a batter getting on base; the batter (team at bat) tries to get "Balls" called in order to get to first base, while the pitcher (team in field) tries to get "Strikes" on the batter.

Related to each level of the goal structure is a set of actions, each of which may take place during the play of a baseball game. These actions are too numerous to consider in any exhaustive sense, but Table 4 presents a list of typical actions. (Table 4 also presents information typical of

the other types of information of the baseball knowledge structure presented in Table 3.)

Table 4

Classification System for Propositions of a Baseball Knowledge Structure

---

I. Setting Information

A. General (SG)

Propositions

Team(s) playing
Team at bat
Team in field
Inning
Inning half
Relevant setting information

B. Specific (SS)

1. Relevant (SSR)

Propositions

Batter information
Batter's batting average
Batter's number of at-bats
Batter's number of hits
Batter's number of doubles
Batter's number of triples
Batter's number of home runs
Batter's speed
Batter's runs batted in
Batter's tendency to hit into double play
Batter's general quality
Batter's bunting ability
Batter's left-right handedness
Batter's clutch-hitting reputation
Batter--pull hitter, straightaway hitter, opposite field hitter
Batter power hitter
Batter "spray" hitter

Pitcher information
Pitcher's earned run average
Pitcher's strike-out record
Pitcher's walk record

Pitcher's left- or right-handedness
Pitcher's run record
Pitcher's inning record
Pitcher's hit record
Pitcher--type of best pitch (fast ball, curve ball, etc.)
Pitcher's ability to prevent stolen bases from occurring
Pitcher--type (starter, relief, long relief)
Pitcher's win-lost record
Pitcher's special characteristics
Pitcher's general quality

Fielder's information
Fielder's position
Fielder's quality at fielding position
Fielder--at specific position - error record
Fielder--at specific position - throwing arm
Fielder--at specific position - ability to field ground balls
Fielder--at specific position - ability to field fly balls
Quality of double-play combination
Fielder's place to play specific batter
Fielder--specific position - specific characteristics

Managerial and coaching information
Tendency to replace pitcher
Tendency to use pinch hitter
General quality and reputation
Tendency to use steal and hit-run
Change-of-state of potential relevance

Pinch hitter
New pitcher
New runner
New fielder
Manager (or coach) expelled

2. Irrelevant (SSI)

Propositions

Baseball information in game context general non-relevant
Information pert. to pitcher
Information pert. to batter
Information pert. to runner
Information pert. to fielder
Information pert. to manager or coach
Information pert. to umpire
Name of player
Name of player at position

Name of player batting or in reference to batting ("on deck")
Name of player in reference to base he is on when a base runner
Commentary on game

C. Enabling (E)

Propositions

Batter comes to bat
Pitcher on mound
Team takes field
Umpires come on field

Listed below are auxiliary actions which would be classified according to the outcome of the play.

Pitcher's actions while pitching
Pitcher throws curve ball
Pitcher throws fast ball
Pitcher throws change of pace
Pitcher throws slider
Pitcher throws knuckle ball
Pitcher throws screw ball
Pitcher throws pitchout
Pitcher throws brushback (ducks)
Pitcher throws to first base
Pitcher throws to second base
Pitcher throws to third base
Pitch is low
Pitch is high
Pitch is outside
Pitch is inside
Pitch is in the dirt
Pitch is wild
Pitch breaks inside
Pitch breaks outside
Pitch breaks down
Pitcher jams batter
Pitcher commits balk

Batter's action
Batter swings
Batter takes pitch
Batter misses
Batter hits ball
Batter's batted ball direction
Ball hit on ground
Fly ball hit
Line drive hit
Ball hit bouncing
Ball hit toward position X (PX is filled with TE, SS, SB, FB, P, RF, CF, LF).

Ball hit between positions PS filled with TS (3rd base - SS) SS (SS - 2B), (SF) 2B. 1B
LC (left-center) CR (cen.er-right) Batter hits ball down line (X - Left or right)
Batter hits foul ball
Batter bunts
Batter drags bunt
Batter arrives at base safely on single, double, triple, or home run
Batter out at base (X - F, S, T, H)
Batter safe on error
Batter safe on walk
Batter safe on passed ball
Batter safe on fielder's choice
Batter reaches base on throw

Runner's information
Runner leads off base
Runner attempts steal
Runner starts running in hit-and-run play
Runner reaches base safely (X = F, S, T, H)
Runner out at base (F, S, T, H) on particular play
Runner goes toward base

Fielder's movements
Fielder's movement to field GB
X = position of fielder, filled in
Fielder catches fly ball (or line drive) successfully
Fielder fields ground ball successfully (Substitute position for F when appropriate.)
Fielder throws ball (to first base, etc.)
Fielder misses fly ball
Fielder misses ground ball
Fielder misses thrown ball
Fielder's throw arrives late

II. Goal Structure and Related Action

A. Level 1

1. Goal Structure Level 1 (G1)
   Team won or lost

2. Action Information Level 1 (A1)
   Action of winning or losing

3. Auxiliary Action Information Level 1 (A1A)
   Action leading to play winning or losing

B. Level 2

1. Goal Structure Level 2 (G2)
   - Score
   - Score differential
   - Team ahead

2. Action Information Level 2 (A2)
   - Action involving change in score

3. Auxiliary Action Information Level 2 (A2A)
   - Action leading to scoring of a run

C. Level 3

1. Goal Structure Level 3 (G3)
   - Number of outs
   - Location of (any) runners (X designates base, 1, 2, 3)

2. Action Information Level 3 (A3)
   - Action in which out is made
   - Action in which batter gets on base safely or runner safely advances to another base

3. Auxiliary Action Information Level 3 (A3A)
   - Actions leading to making an out
   - Actions leading to batter reaching base safely and/or runner reaches base safely

D. Level 4

1. Goal Structure Level 4 (G4)
   - Number of balls on batter
   - Number of strikes on batter
   - Count (ball - strike)

2. Action Information Level 4 (A4)
   - Pitch is ball
   - Pitch is strike

3. Auxiliary Action Information Level 4 (A4A)*
   - Pitcher delivers ball
   - Pitch is curve
   - Pitch is fast ball
   - Pitch is slider
   - Pitch is change of pace
   - Pitch is screwball
   - Pitch is knuckleball
   - Pitch is spitter
   - Pitch is pitchout
   - Batter takes pitch

Batter swings
Batter hits ball
Etc.

*Some actions may be A3A, A2A, or A1A, depending upon outcome.

III. Non-Game Actions

A. Non-Game Actions - Relevant (NAR)
(Actions are related in some way to the game, but not changes in goal structure.)
Manager's actions
Coach's actions
Catcher's actions
Fielder's actions
Cause for NAR action
Miscelleanous actions
Pitcher's actions
Umpire's actions

B. Non-Game Actions - Irrelevant (NAI)
Irrelevant game actions
Pitcher's action
Batter's actions
Runner's actions
Umpire's actions
Miscellaneous actions
Catcher's actions
Cause for NAI action

C. Non-Game Actions - Irrelevant (Non-Baseball) (NANB)
Irrelevant non-baseball information
Fan action
Weather action
Action in stands
Miscellaneous action

Another aspect of the action classification is the inclusion of a category at each level called auxiliary actions. These are actions which are part of a play leading to a goal action but not the action itself. For example, the text may state, "The batter hit a fly ball to left field. The left fielder took three steps to the right. The left fielder caught the ball and the batter was out." The action that involves the goal state is in the final sentence, but the

first sentences contain information that is part of the play. This type of action is termed auxiliary.

The propositions shown in Table 2a were classified in terms of goal states and game actions. The former are denoted by G, followed by a number indicating the level of goal state involved in that proposition. Game actions are denoted by A, followed by a number indicating the level. An A following the number denotes that the action is auxiliary, for example, A1A.

A note is inserted here to answer some potential questions. The goal state propositions are those which make explicit a change in the state of a particular component of the goal structure. If a runner reaches second base safely, that is a change in the state. How the runner reached second (i.e., by hitting a double, by "stealing" second base, by an error, etc.) is an action.

The final knowledge structure information shown in Table 3 is termed non-game actions. These are actions that are not part of the game per se, but actions that may occur during a particular game. An example is a batter wiping his/her hands with a resin bag.

Non-game actions are classified in three ways. First, relevant actions are in some way related to the game even though they are not related to the play of the game. The second category, irrelevant actions, consists of actions less related to the game. The third category, irrelevant (non-baseball) actions, consists of actions not at all related to baseball. Examples of these three types of actions are found in Table 4. In the propositional classification of Table 2a, the three types of non-game actions are denoted, respectively, as NAR, NAI, and NANB.

The Scoring of Protocols

The protocol scoring method was quite straightforward. Each protocol was read sentence by sentence and the information contained in each sentence was scored in terms of the propositional analysis of Table 2a. Credit was thus given for the particular propositions whose contents were contained in the protocol. The reliability of this method, obtained by two raters with blind scoring of 16 (of 46) protocols, was 81% and 78% for HK and LK, respectively.

Tables 5 and 6 present a protocol of a HK and LK subject, respectively. Tables 7 and 8 present the propositions listed in Table 2A as they were recalled in the protocols of Tables 5 and 6, respectively.

Table 5

A High-Knowledge Protocol

The Robins and the Cougars are playing in a 5-3 game, favor of the Robins. It is in the last of the fifth and it is raining. The left-handed pitcher (E.R.A. 6.0) is having a usual day, 4 hits, 6 strikeouts (he usually gets a lot of strikeouts). The first batter flies out bringing up Johnson, a .310 power hitter who leads the league with 23 homers. The first pitch is an inside curve ball for a strike. Johnson then raps a long foul which is followed by a brushback pitch. Johnson starts toward the mound, but then just goes to put resin on his slippery bat. The next pitch is an inside slider to even the count 2-2. Again Johnson puts resin on the bat. The next pitch is lined to left field for a double. The next batter, a .260 hitter, beats out an infield single to short, Johnson holding second. A .255 hitter follows, and the first pitch to him sails by the catcher and the runners each move up a base. He then shoots a single up the middle. Johnson scores but the runner on second is out trying to score. The runner advances to second on the throw. Beck, a relief pitcher, starts to warm up, but the last batter strikes out to end the inning. The umpires then confer, and the game is called.

Table 6

A Low-Knowledge Protocol

The score was 5-3. At the start of the inning, the sky started getting dark and as the inning went on it began raining and the game had to be called. The first batter of the inning had an average of .310, and the pitcher had allowed only 4 hits. The batter did not make it on base, and the pitcher was relieved because the next batter was very good. At one point, his count was 2 and 2. One of the batters had to use resin on his hands twice because the bat was slippery due to the rain. Someone's E.R.A. was 6.00. One of the batter's names was Churniak.

Table 7

Propositions Correctly Recalled for HK Protocol
(By Numbers from Table 2a)

1	76	141
2	78	146
3	80	163
4	81	167
6	82	168
7	85	170
8	86	183
9	87	193
17	88	194
19	89	196
20	90	199
22	92	208
23	93	251
24	95	253
25	96	254
38	97	257
40	98	263
43	102	264

45	103
46	106
48	108
49	110
54	113
55	117
58	127
61	129
62	134
67	135
72	137

Table 8

Propositions Correctly Recalled for LX Protocol
(By Numbers from Table 2a)

3
8
9
15
17
20
25
43
52
80
81
82
90
92
93
115
257
258

The Scoring of the Questionnaire

In the procedure used by Spilich et al. (in press), the subjects were given a series of 40 questions on the contents of the text after they had recalled the contents of the text. The purpose of the questionnaire was (a) to determine whether HK and LK differences would occur on this type of test, and (b) to determine whether HK and/or LK individuals were able to recall information (via question probe) that was not stated in the recall protocol. While HK individuals yielded better recall than LK individuals on the questionnaire performances, both groups recalled information in response to questions which they had not stated in their recall protocols. The questions employed in the questionnaire are presented in Table 9. (The order of questions generally follows the order of the text.)

Table 9

Questionnaire

1. What was the score of the game at the beginning of the account?
2. Which team was ahead?
3. Who were the teams that were playing?
4. Which team was at bat during the account?
5. Was the team at bat the home or visiting team?
6. What were the weather conditions?
7. Who was the pitcher for the team in the field?
8. Who was the first batter in the account?
9. What was his batting average?
10. Was he right- or left-handed?
11. What was the pitcher's earned run average?
12. Was he a good pitcher? Why or why not?
13. What parts of his own body or uniform did the pitcher touch before delivering the ball?
14. What happened when the first batter hit the ball?

15. What was the ball-strike count on him when he hit the ball?
16. Who was the second batter?
17. What was his batting average?
18. How many home runs did he hit?
19. Why did this batter take a step toward the pitcher?
20. What did this batter do? How?
21. What was the ball-strike count on this batter when he hit the ball?
22. Why did this batter use a resin bag?
23. Who was warming up in the bullpen? Why?
24. Who was the next batter?
25. What happened when he hit the ball?
26. What was the ball-strike count on the batter when he hit the ball?
27. Why did the runner on base not advance when this man hit the ball?
28. After this man batted, on which base(s) (was) (were) the (runner) (runners)?
29. Who was the next batter?
30. What was his batting average?
31. What happened that affected the (man) (men) on base?
32. What happened when this batter hit the ball?
33. What kind of pitch did he hit?
34. What happened to the runner(s) when this batter hit the ball?
35. Who was the next batter?
36. What was his batting average?
37. What happened to this batter?
38. Name as many players on the team in the field and state their positions.
39. Was the game official? How do you know?
40. What was the score at the end of the account?

Question	Number of Correct Responses (of 23) for HK	Question	Number of Correct Responses (of 23) for HK
1	16	21	10
2	18	22	21
3	19	23	10
4	16	24	3
5	17	25	21
6	23	26	4
7	15	27	20
8	6	28	21
9	13	29	1
10	12	30	5
11	20	31	17
12	15	32	19
13	12	33	0
14	20	34	*
15	4	35	5
16	10	36	5
17	2	37	10
18	15	38	25**
19	20	39	13
20	19	40	15

* Question #34 thrown out due to redundancy

** Eight correct responses per subject were possible

Question	Number of Correct Responses (of 23) for LK	Question	Number of Correct Responses (of 23) for LK
1	12	21	7
2	9	22	17
3	14	23	7
4	14	24	2
5	12	25	10
6	22	26	0
7	11	27	8
8	5	28	13
9	3	29	0
10	16	30	3
11	8	31	9
12	2	32	10
13	12	33	1
14	9	34	*
15	2	35	1
16	9	36	0
17	0	37	9
18	6	38	9**
19	8	39	10
20	8	40	6

* Question #34 thrown out due to redundancy

** Eight correct responses per subject were possible

While the more important results of this phase of the experiment were discussed by Spilich et al. (in press), the results for each question were not presented. Table 9 therefore also indicates the number of correct answers given by the 23 high-knowledge and 23 low-knowledge subjects in the experiment.

Final Comments

This paper presented in detail the procedures used for the text analysis and protocol analysis of the Spilich et al. paper. Also included is a summary of the results of the questionnaire given. While the methodology cannot be noted for its precision, it did involve procedures that were reliable and were apparently valid.

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